Psychometric profile of children with auditory processing disorder and children with dyslexia

Piers Dawes,1 Dorothy V M Bishop2

ABSTRACT

Objective The aim was to address the controversy that exists over the extent to which auditory processing disorder (APD) is a separate diagnostic category with a distinctive psychometric profile, rather than a reflection of a more general learning disability.

Methods Children with an APD diagnosis (N=25) were compared with children with dyslexia (N=19) on a battery of standardised auditory processing, language, literacy and non-verbal intelligence quotient measures as well as parental report measures of communicative skill and listening behaviour. A follow-up of a subset of children included a parent report screening questionnaire for Asperger syndrome (Childhood Asperger Syndrome Test).

Results There were similarly high levels of attentional, reading and language problems in both groups. One peculiarity of the APD group was a discrepancy between parental report of poor communication and listening skill disproportionate to expectations based on standardised test performance. Follow-up assessment suggested high levels of previously unrecognised autistic features within the APD group.

Conclusions Children diagnosed by audiological experts as having APD are likely to have broader neurodevelopmental disorders and would benefit from evaluation by a multidisciplinary team.

INTRODUCTION

Auditory processing disorder (APD) is suspected when a child presents with unexplained listening difficulties. The primary feature is difficulty hearing in background noise despite a normal audiogram. APD is widely diagnosed in the USA and Australia,1 2 and is beginning to receive more research and remains controversial. 5 8 In this study, we focused on whether the psychometric profile of children with an APD diagnosis differed from that of children with dyslexia. During an initial assessment, all participating children completed a detailed psychometric battery comprising standardised assessment and parent report measures. On the basis of our findings, a follow-up assessment focusing on a screening assessment of autistic features was conducted with a subset of children from both APD and dyslexia groups.

METHOD

Participants

APD group

After excluding two children with a low non-verbal intelligence quotient (IQ) (<80) and one child for poor compliance during testing, 25 children diagnosed as having APD were recruited from audiology clinics based at four hospitals in the UK. All of these children had been diagnosed by an Audiologist or Audiological Physician as having APD. Diagnosis at each of these centres was based on (1) complaint of listening difficulties, (2) normal peripheral hearing, (3) score below the recommended clinical cut-off on the SCAN-C or -A9 10 plus and (4) failure on one or more additional non-speech tests of auditory processing (eg, Pitch Patterns or Duration Patterns Test11 or

What is already known on this topic

- Auditory processing disorder (APD) is diagnosed on the basis of listening difficulties and poor performance on tests of auditory processing despite a normal audiogram. There is debate over whether APD is a separate diagnostic entity in its own right with a distinctive psychometric profile, or whether it is a reflection of a more general learning disability.

What this study adds

- Children with a diagnosis of APD have high levels of attentional, reading and language difficulties. A substantial minority may also have autistic features. These children are therefore likely to benefit from evaluation by a multidisciplinary team.
the Random Gap Detection Test. This method of APD diagnosis is typical of clinical identification of APD in the USA and UK.

Dyslexia group

Nineteen children were recruited either from local schools or as participants from previous studies; all had a diagnosis of dyslexia by an educational psychologist. For inclusion in the study, dyslexia was defined as a reading or spelling test standard score below 85 and a non-verbal IQ greater or equal to 80 (see Assessments). All participants had normal hearing as indicated by pure-tone audiometric screening test (at 20 dB HL for 250 Hz to 8 kHz). Parental consent for participation was obtained in accordance with University and NHS ethics requirements.

Assessments

Testing was carried out in a quiet room by a trained examiner.

Psychometric tests

- Wechsler Abbreviated Scale of Intelligence matrix reasoning and block design subtests. Non-verbal IQ is calculated as a composite of matrix reasoning and block design subtests.
- Test for Reception of Grammar, electronic version (TROG-E). The TROG-E is a test of receptive language that assesses comprehension of grammatical contrasts marked by inflections, function words and word order.
- Expression, Reception and Recall of Narrative Instrument (ERRNI). ERNII assesses the ability to relate a pictured story, and recall and answer questions about it after a short interval. Children's performance is compared with UK norms according to how much relevant story content is provided, sentence length, comprehension and recall of the story.
- Sentence Repetition and Repetition of Non-sense Words from NEPSY. These tests, which are sensitive indicators of language impairment, tap short term memory.
- Test of Word Reading Efficiency (TOWRE). The TOWRE assesses the ability to read real words and non-words under time pressure.
- The OSCCI spelling test was developed within our research group as a quick and efficient test of spelling ability. Children are asked to write a list of regular and irregular words within a 2 min time limit. Performance norms are based on 58 typically developing British school children aged 6–15 using the regression of score on age to convert to age-adjusted standard scores.
- SCAN-C and SCAN-A. The SCAN is a US-produced standardised test of auditory processing, and is the most commonly used instrument for diagnosis of APD. (Note that current recommendations are that the SCAN or similar test form part of a comprehensive test battery for APD diagnosis. APD diagnosis is not recommended on the basis of the SCAN alone.)
- Test takers repeat monaurally presented single word stimuli that have been acoustically filtered to reduce intelligibility or are presented against a background of multitalker babble, as well as single words and sentences that are presented dichotically. Stimuli are recorded on compact disk and presented via headphones. Accuracy of responses is scored and compared with performance norms to provide standard scores. The child version, the SCAN-C, is for use with children aged 5–11, while the SCAN-A is for those aged 12 and above.

RESULTS

APD and dyslexia groups did not differ in age (means of 10.4 years, SD 2.5 and 10.1 years, SD 1.6 respectively, t(42)=−0.48, p>0.05). There was a higher proportion of males in the dyslexia group (17/19 cases) than in the APD group (15/25 cases), Fisher p=0.04. The two groups were not significantly different in non-verbal IQ (M=98.7, SD 14.8 and M=102.2, SD 11.4, respectively for APD and dyslexia groups, t(42)=0.86, p>0.05).

Comorbid conditions

Rates of dyslexia, SLI as well as attentional and auditory processing problems were examined in the APD and dyslexia groups. Dyslexia criteria were as used for dyslexia group selection. SLI was defined as a non-verbal IQ of 80 or better and performance on two or more out of six language tests (TROG, NEPSY sentence repetition, NEPSY non-word repetition, ERNII storytelling, ERNII MLU, ERNII story comprehension) below −1 SD. Around half (15 of 25, 52%) of APD children would also fit a diagnosis of SLI, dyslexia or both. A relatively high proportion of children in the dyslexia group would also fit a diagnosis of SLI (11 of 19, 58%). The proportion of children who fit a diagnosis of SLI was not statistically significantly different between the APD group and the dyslexia group (Fisher p=0.36). Hyperactivity/inattention was identified using recommended cut-off scores for the parent-completed SDQ and Strengths and Difficulties Questionnaire (SDQ).

Parental questionnaires

- Children’s Communication Checklist—2 (CCC-2). The CCC-2 is a parent-completed questionnaire that can be used to screen for language impairment, to identify pragmatic impairments in children with communication problems and to identify children as candidates for further assessment for an autistic spectrum disorder. The CCC-2 provides norm-referenced scores in 10 linguistic and pragmatic subscales as well as providing an overall index of communicative competence and a social interaction deviance score, which can be used to identify children with a communicative profile characteristic of autism.
- Childhood Asperger Syndrome Test (CAST). The CAST is a screening test for autistic spectrum features in children aged 4–11, which was completed by parents of a subset of cases 6–8 months after the rest of the battery. Parents respond with a yes or no to statements such as ‘Does s/he tend to take things literally?’ or ‘Is her social behaviour very one-sided and always on his/her own terms?’ The number of ‘yes’ answers is then totalled.

ARCH DIS CHILD 2010; 95:432–436. doi:10.1136/adc.2009.170118
Table 1 Mean (SD) scores by group

<table>
<thead>
<tr>
<th>Group</th>
<th>Auditory processing disorder</th>
<th>Dyslexia</th>
<th>F statistic</th>
<th>Effect size (ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCAN</td>
<td>91.00 (19.12)</td>
<td>97.20 (16.28)</td>
<td>1.24</td>
<td>.07</td>
</tr>
<tr>
<td>Language composite</td>
<td>94.21 (11.22)</td>
<td>93.25 (7.84)</td>
<td>0.10</td>
<td>.14</td>
</tr>
<tr>
<td>Literacy composite</td>
<td>84.50 (16.97)</td>
<td>75.33 (9.27)</td>
<td>5.24†</td>
<td>.27</td>
</tr>
<tr>
<td>Children’s Auditory</td>
<td>−2.09 (0.77)</td>
<td>−1.6 (0.67)</td>
<td>3.65*</td>
<td>.24</td>
</tr>
<tr>
<td>Performance Scale total</td>
<td>37.74 (15.68)</td>
<td>46.37 (23.29)</td>
<td>1.31†</td>
<td>.16</td>
</tr>
</tbody>
</table>

*p<0.05.
†Welch’s F statistic.
‡An average general communication composite is 82, with lower scores suggesting poorer communication skills.

The ‘literacy composite’ is the average of the standard scores of three literacy tests (OSCCI spelling, TOWRE word and non-word reading). The mean composite scores are shown in table 1. Unsurprisingly, as the group was selected on the basis of poor literacy skills, the dyslexic group did significantly worse on the literacy composite, although both groups’ average literacy score was below −1 SD. Groups did not differ significantly on language composite or SCAN composite score.

For parent-completed questionnaires, the APD group scored worse on the CHAPS listening behaviours questionnaire. There was no difference in overall CCC-2 general communication composite (GCC) score. An ANOVA was carried out to compare the average score on each CCC-2 subscale between groups. Both groups scored similarly low on speech, syntax and semantics (an average subscale score is 10 with SD 3, shown in figure 1 by a dotted line). After adjusting for multiple comparisons (p<0.005), there were no significant differences between groups on any subscale. ‘Use of context,’ ‘non-verbal,’ ‘social’ and ‘interests’ subscales were approaching significance (p=0.02–0.06). These subscales are associated with autistic spectrum disorders. Overall, both structural language and pragmatic problems were a feature of children with suspected APD.

Discrepancy between parental report and standardised tests

During evaluation of individual test results, it was noticed that parents of APD participants tended to rate their children less well on the CCC-2 than their child’s performance on standardised language tests would suggest. This tendency was examined statistically. GCCs from the CCC-2 were converted to standard scores for comparison with the standardised language composite to have a mean of 100 and a SD of 15. The magnitude of the discrepancy between parental communication checklist and standardised language test was then calculated as the language composite minus the standardised total CCC-2 score (DISCREP). There was a group difference in the magnitude of the average discrepancy score, with the APD group significantly higher (APD M=24.52, SD 11.99, dyslexia M=16.88, SD 11.29, t(41)=−2.10 p<0.05, r=0.31).

One possibility that may explain the discrepancy between parent report of poor communicative competence and relatively good standardised test performance is that while these children may have a relatively good structural language, they have difficulties using language appropriately and effectively in more demanding communicative situations. CCC-2
subscales on which group differences were approaching signifi-
cance were associated with autistic spectrum disorders, with
the APD group being rated worse on these pragmatic subscales
(though non-significant after correction for multiple comparisons).

This raised the question of some children with a diagnosis of
APD having unidentified autism spectrum disorders, lead-
ing us to obtain approval from the NHS Ethics Committee to
obtain additional information from the CAST, 6–8 months after
the initial study. Valid CAST questionnaires were received from
the parents of 12 dyslexia and 18 APD participants. Average CAST raw scores were significantly higher in
the APD group than in the dyslexia group (11.1 SD 5.5 vs 5.2
SD 2.3, t(28)=−3.4, p<0.01, r=0.54). The recommended cut-off
score for identification of possible clinical cases is 15. Applying
this criterion yielded six cases within the APD group (33%)
and no cases within the dyslexia group. This difference was
marginally non-significant (Fisher p=0.06, two-sided). There
was no correlation between DISCREP and CAST raw score
(r=0.27, NS).

DISCUSSION
We were interested in whether children diagnosed as having
APD have a distinctive pattern of psychometric performance,
and whether the pattern differed from that of children with
dyslexia. Around half of the children diagnosed as having APD
would fit a diagnosis of dyslexia or SLI or both. Conversely,
the dyslexia group scored similarly to the APD group on the
SCAN test of auditory processing. A high prevalence of atten-
tion/hyperactivity problems was also a feature of both groups.
While there was a trend for the APD group to do worse than
the dyslexia group on all the behavioural measures, the only
significant difference in performance between groups was on
literacy measures, where the dyslexia group, who had been
selected on this basis, did worse. Average literacy scores for
the APD group were also poor. In terms of severity of atten-
tional, reading, language and auditory processing skills, the
difference between APD and dyslexia children is quantitative
rather than qualitative, with APD diagnosed children tending
to have more severe problems.

One characteristic that did distinguish between these two
groups was that in the APD group, there was an unusual dis-
crepancy (DISCREP) between parental ratings of poor commu-
nication/hyperactivity problems to some sounds, such as ignoring someone calling their
own name, while also being hypersensitive to sounds, such as
hearing sounds that others cannot or exhibiting extreme aver-
sive reactions to innocuous sounds.20,31

In summary, children diagnosed as having APD did not dif-
er qualitatively from those with dyslexia in their performance
on psychometric tests of IQ, auditory processing, language or
literacy, though there was a tendency for children with APD
to perform worse across all measures. In contrast to those with
dyslexia, children with APD showed a discrepancy between
parent report of poor communicative competence and rela-
tively good performance on standardised language tests. We
suggest that pragmatic problems associated with autistic spec-
trum disorder, to which standardised tests are largely insensi-
tive, may partially explain this discrepancy. The most striking
finding was that a third of children with an APD diagnosis
fell within the clinical range on a screening questionnaire for
Asperger syndrome, though ASD had not been formally rec-
ognised for most of these cases. This finding deserves further
investigation with a larger sample of children with suspected
APD. It may be useful to screen children referred to APD clin-
ics for ‘listening difficulties’ for communication problems
associated with unrecognised ASD. Effective management
might then centre on remediating these children’s pragmatic
difficulties. Many children with APD do have demonstrable
learning problems, though it is unclear to what extent their
reported listening problems are due to actual difficulties with
auditory processing, language difficulties or ASD.

Acknowledgements This study was funded by Deafness Research UK. Thank
you to T Sirimanna (Great Ormond Street Hospital), F Tweedy (Manchester Royal
Infirmary), M Burton (John Radcliffe Hospital) and I Vanniasegaram (St Georges
Hospital) for help with recruitment of subjects.

Funding Deafness Research UK, 330–332 Gray’s Inn Road, London WC1X 8EE.

Competing interest None.

Provenance and peer review Not commissioned; externally peer reviewed.

Patient consent Obtained from the parents.

Ethics approval Ethics approval was provided by the Oxfordshire REC B,
University of Oxford Ethics Committee.

REFERENCES
1. Cameron S, Dillon H. Auditory processing disorder—from screening to diagnosis
2. Emanuel DC. The auditory processing battery: survey of common practices. J
2006;4:12–24.
consensus statement by the German Society for Phoniatry and Paeedaudiology.
5. Dawes P, Bishop D. Auditory processing disorder in relation to development
al disorders of language, communication and attention: a review and critique. Int J
6. Friel-Patti S. Clinical decision-making in the assessment and intervention of
7. Tallal P. Improving language and literacy is a matter of time. Nat Rev Neurosci
8. Rosen S. Auditory processing in dyslexia and specific language impairment: is
there a deficit? What is its nature? Does it explain anything? J Phonetics
9. Keith RW. SCAN-A: a test for auditory processing disorders in adolescence and
11. Musiek FE. Frequency (pitch) and duration pattern tests. J Am Acad Audiol
conduction threshold audiometry with and without masking and determination of
uk/docs/RecPro/PTA.pdf [accessed 22 March 2010].
Psychometric profile of children with auditory processing disorder and children with dyslexia
Piers Dawes and Dorothy V M Bishop

Arch Dis Child 2010 95: 432-436
doi: 10.1136/adc.2009.170118

Updated information and services can be found at:
http://adc.bmj.com/content/95/6/432

These include:

References
This article cites 17 articles, 0 of which you can access for free at:
http://adc.bmj.com/content/95/6/432#BIBL

Open Access
This is an open-access article distributed under the terms of the Creative Commons Attribution Non-commercial License, which permits use, distribution, and reproduction in any medium, provided the original work is properly cited, the use is non commercial and is otherwise in compliance with the license. See: http://creativecommons.org/licenses/by-nc/3.0/ and http://creativecommons.org/licenses/by-nc/3.0/legalcode

Email alerting service
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

Topic Collections
Articles on similar topics can be found in the following collections

Open access (202)
Asperger syndrome (2)
Child health (3922)
Pervasive developmental disorder (138)
Autism (133)
Child and adolescent psychiatry (paediatrics) (683)
Disability (288)
Screening (epidemiology) (553)
Screening (public health) (553)

Notes

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/